# Hooked on fossils

**For decades, much of the early history of fish evolution was locked away in rocks in China. Rex Dalton tracks down the scientist who brought many of the remains to the surface.**

Chipping away: Meemann Chang has devoted her life to finding and understanding fossilized fish.

The dry desert setting of Mesa, Arizona, may not seem the most appropriate place to talk about the watery world of fish. But palaeontologists gathered in a lecture hall there last autumn to celebrate a life spent studying ancient oceans and the fish that swam in them.

The symposium, held by the Society of Vertebrate Paleontology, celebrated one of China's most prominent palaeontologists — Meemann Chang, former head of the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP) in Beijing. Her work has helped clarify the links between the fish that swam in Earth's oceans 400 million years ago and the air-breathing, land-walking creatures that evolved from them. Now 69, she has played a key role for years in bringing little-known Chinese fish fossils to the attention of the scientific world.

Chang's career has been far from straightforward. Along with her successes, she has also faced significant difficulties, thanks to the shifting political landscape of her homeland. Despite such problems, her enthusiasm for her subject remains undimmed. "I am still digging and collecting fossil fishes," she smiles during an interview at the landlocked Arizona hotel.

Chang's father, a gifted pathologist from Nanjing, wanted her to become a physician, but love of her country led her to choose geology instead. In 1958, during the Great Leap Forward, she was among those who heeded the call of vice-president Liu Shaoqi to study the Earth so that China might exploit its natural resources, such as oil. For Chang, that introduction to China's rocks set her on the path to study fish fossils, a quest that has taken her to all the continents of the world.

In 1965, Chang was chosen to do graduate research at the Swedish Museum of Natural History in Stockholm, one of the leading research centres in palaeontology. But her time there was to prove short-lived. When the Cultural Revolution swept China in 1966, Chang, ever the patriot, halted her studies and returned home. In Beijing, Chang was confronted by the new phenomenon of the Red Guard who, on the orders of Mao Zedong, 'purified' China by isolating and punishing the academic classes.

## Bad dream

For more than a decade, Chang lived what is now called the 'time of nightmares' — public humiliations to challenge the intellectual spirit, and hard labour in the countryside to break the body. "I wasn't allowed to do research," she recalls, "only to read Mao." It would be many years before Chang was able to return to Sweden to complete her doctorate.

"She is a wonderful person who has been through a lot," affirms John Maisey, curator of fossil fish at the American Museum of Natural History in New York and one of the organizers of the Mesa meeting. "But she still smiles and is charming."

Missing link: remains of the fish *Youngolepis* have helped plug gaps in the evolutionary tree.

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Chang's career has taken her through many countries, and allowed her to pick up numerous languages. She earned her undergraduate degree in 1960 at the Lomonosov Moscow State University, where she became fluent in Russian. She learned modest Swedish while in Stockholm, is fluent in English and reads German and French. But she is also adept at deciphering another language: that of fossilized remains[1]. She can readily navigate a path from the 'age of fish' 400 million years ago in the Devonian period, through to the end of the dinosaur age and the Cretaceous period 65 million years ago.

In her current studies, Chang is working to understand the species distribution pattern of fish across the Pacific Ocean — a distribution that reached its maximum during the Eocene epoch, between 34 million and 56 million years ago. Most of these fish became extinct in the western Pacific, she notes, but a few, such as the coelacanth, still survive in the eastern Pacific. "Tracing the origins and distribution of these fish is a very exciting endeavour," she says.

Chang's contribution to Chinese palaeontology was recognized in 1983 when she became the first woman to head the IVPP. This was significant not only because of her gender

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but because it marked the IVPP's move away from political appointments to those based on merit. Chang served two terms as director, ending her tenure in 1990, and helped shepherd the institute from the days when whole families were living on an upper floor of the research building, to a new facility that included modern laboratories.

Unlike some of her more rigid compatriots, Chang was very flexible and open when it came to guiding her students' careers, says palaeontologist Desui Miao, who helped to organize the Mesa symposium. He cites the case of Zhonghe Zhou as an example. One of Chang's promising students, Zhou had begun a doctoral programme in the early 1990s to examine fossil fish. But then quarries in the northeastern province of Liaoning started to yield an intriguing assortment of fossilized birds dating back to the early Cretaceous.

Zhou saw this as an opportunity to switch from fish to avian fossils. Chang agreed, allowing him to change the direction of his research. "This was a major break with Chinese tradition," says Miao, of the University of Kansas in Lawrence. "But it showed how she treated every student," he adds — working first and foremost to develop them professionally.

The change more than paid off. What began as a seemingly minor academic move helped pave the way for China to become a leading force in palaeontology. Liaoning's avian-like fossils of feathered dinosaurs with rapacious teeth redefined how birds evolved[2]. Soon, the world's top palaeontologists were clamouring to come to China, which in turn generated collaborations and opportunities abroad for young Chinese researchers.

Miao himself was among those who benefited from these new links — in the late 1980s, he found himself studying at the University of Chicago. Once more, Chang was to show her willingness to put her students' interests first. In 1988, Miao knew he wanted to continue his postdoctoral studies in Chicago, but at that time China's leaders, worried about a country-wide 'brain drain', were pushing for foreign-trained scientists to return home.

## Taking a gamble

Miao decided to write to Chang, asking her permission to stay in the United States. A Chinese colleague thought this was a rash move, calling him a "bloody fool", Miao remembers. But soon after, Miao received a letter from Chang granting her permission. "I was stunned," he recalls. "For the first time in a long time, I wept."

Chang's experiences in Stockholm, of course, meant that she knew only too well the difficulties of studying abroad. But she also understands the rewards. Despite the interruption by the Cultural Revolution, her research in Sweden did much to rework the evolutionary tree for fish — and sparked some very lively debate.

Hans-Peter Schultze, a palaeontologist who was doing a postdoc at the Stockholm museum in the early 1960s, remembers the rumours of fabulous specimens from the early Devonian that Chang had brought from quarries in Yunnan province. At the time, palaeontologists regularly argued about the evolutionary tree of fish before species evolved to move ashore. Such trees, or cladograms, are important in understanding historical biodiversity and specialized characteristics of current species.

Swedish palaeontological icons Erik Stensiö and Erik Jarvik — both now deceased — held strongly to a view about the split between two lineages of Devonian fish: lungfish (dipnoans) and lobe-finned fish (porolepiformes). Before Chang's work, there was no known species that shared characteristics from both these types of fish, which were the predecessors of creatures that later walked on land and breathed air. But Chang had a fossilized fish that did: *Youngolepis*, a specimen dating from around 415 million years ago in the Devonian[3].

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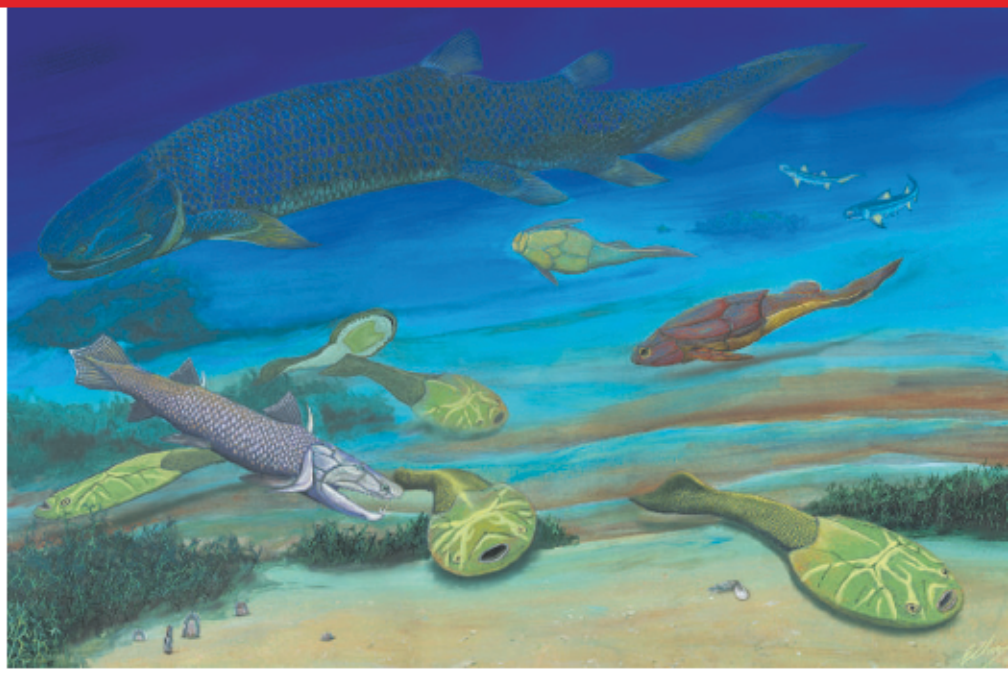
"It was very disturbing for them when Chang brought the new form," says Schultze, who is now at the University of Kansas. "Jarvik called *Youngolepis* the 'devil's fish'." In jest, Chang later used that epithet to name another Chinese specimen, *Diabolepis*, which furthered her theories of the link between lungfish and lobe-finned fish. Her specimens "became pivotal in strengthening the connection" between these species, says Schultze, and helped to lay the groundwork for Chang to propose an evolutionary history for the fishes. Debate over this history continues today, with some authors using cladograms to challenge her conclusions about how closely *Youngolepis* and *Diabolepis* are related to the dipnoans.



Reconstruction of fossilized fish found in the Yunnan province, including *Youngolepis* (upper left).

Lars Werdelin, a graduate student in Stockholm when Chang returned to complete her graduate degree, says her understated manner made her data even more convincing. "She doesn't stretch the evidence," says Werdelin, now senior vertebrate curator at the Stockholm museum. "She is not prone to hyperbole. When she says something, you believe it."

Although colleagues often tell of Chang's personal warmth, they acknowledge that she also has a steely, determined side. In the late 1950s, she was a student leader charting a future field trip in a dangerous area of Kazakhstan. Outsiders were loathed then, and hotels used to deny foreigners a room. "She demanded a room — arguing, patting her side and saying: 'I have money. I have money'," says Ke-Qin Gao, a palaeontologist at Peking University in Beijing, who heard the story later. "She was fearless." And she got the room.

Today, Chang never tells such stories. Asked about her successes, she brushes aside the questions, seeking credit for her students and colleagues.

Fortunately, her students and colleagues have found a way to honour her record. Xiaobo Yu, a palaeontologist at Kean University in Union, New Jersey, is preparing a book based on the Mesa symposium. Yu couldn't go to college during the Cultural Revolution. But afterwards, Chang took him on as her first graduate student. It set him on a course to receive his doctorate from Yale University. ■

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1. Chang, M. *Nature* **403**, 152–153 (2000).
2. Hou, L.-H., Zhou, Z., Gu, Y. & Zhang, H. *Chinese Sci. Bull.* **10**, 61–63 (1995).
3. Chang, M. in *Origins of the Higher Groups of Tetrapods: Controversy and Consensus* (eds Schultze, H.-P. & Trueb, L.) 3–28 (Cornell Univ. Press, Ithaca, New York, 1991).